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ENLISTED PERSONNEL INDIVIDUALIZED CAREER SYSTEM (EPICS): ACCEPTANCE AND USE OF JOB PERFORMANCE AIDS (JPAs)

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ENLISTED PERSONNEL INDIVIDUALIZED CAREER SYSTEM (EPICS): ACCEPTANCE AND USE OF JOB PERFORMANCE AIDS (JPAs)

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This report provides results of the test and evaluation (T&E) of the job performance aids (JPAs) developed within an integrated personnel system framework and in accordance with the principles of job design for use in the Enlisted Personnel Individualized Career System (EPICS). Attitudinal data on JPAs were collected after EPICS personnel had been onboard ship approximately 15 months. Shipboard administrators and EPICS personnel assessed the JPAs as well-designed, complete sources of technician information. EPICS personnel of varying FT eligibility, general aptitude, and reading ability preferred JPAs for first time and infrequently occurring tasks. Because of better implementation in the Atlantic fleet, target personnel in the Atlantic fleet preferred JPAs more for all task types than did personnel in the Pacific fleet.

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FOREWORD

This research and development was guided by Navy Decision Coordinating Paper (NDCP) Z0828-PN (Enlisted Personnel Individualized Career System (EPICS), formerly entitled, Performance Aids Test and Evaluation) under the sponsorship of the Deputy Chief of Naval Operations for Manpower, Personnel, and Training (OP-01). The objectives of the NDCP are to define the state of the art in job performance aid (JPA) technology, develop a conceptual model for an integrated JPA-based personnel system including cost benefits and tradeoff analysis, test the JPA concept, and quantify performance increments and costs benefits obtainable for various applications.

This report is the tenth in a series of Navy Personnel Research and Development Center reports dealing with JPA technology development: (1) NPRDC TR 77-33 includes seven papers assessing the state of the art in JPA technology, (2) NPRDC TN 78-6 describes a preliminary enlisted personnel system concept with major emphasis on the use of JPAs, (3) NPRDC TR 78-26 is a systematic review and organization of existing JPA techniques, related research data, and various applicable principles and concepts, (4) NPRDC TN 79-1 defines a JPA selection algorithm for an integrated personnel system, (5) NPRDC TR 79-25 discusses development of hybrid and enriched hybrid troubleshooting JPAs, (6) NPRDC TR 82-7 describes the development and test of a troubleshooting aid for digital systems, (7) NPRDC SR 83-32 describes a field evaluation of enriched hybrid troubleshooting JPAs, (8) NPRDC SR 83-39 presents 12 papers on factors influencing JPA cost and methods for measuring and predicting these cost factors, and (9) NPRDC TR 85-24 details enriched hybrid JPA development. The purpose of the present effort was to describe how fully and partially procedural zed JPAs developed for the EPICS test and evaluation were accepted and used by EPICS participants. Results are intended for the JPA and technical documentation community.

Appreciation is expressed to Mr. Robert Bowles, Naval Ship Weapon Systems Engineering Station, Port Hueneme, California, who was instrumental in providing technical data for JPA development and who assisted directly in JPA validation.

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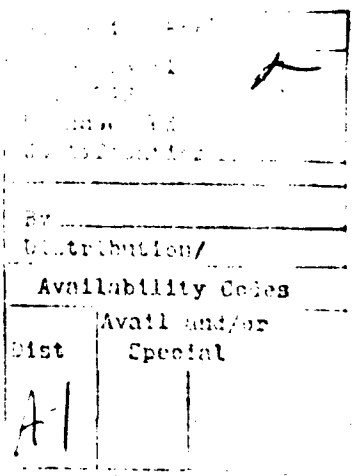

SUMMARY

Problem and Background

In the maintenance environment, technicians perform specific maintenance tasks, which are mostly procedural and usually supported with some kind of technical documentation. One form of technical documentation that has been shown to be effective is the job performance aid (JPA). JPAs are proceduralized instructions that have been used to reduce training time, facilitate successful task performance, and increase utilization of inexperienced personnel. Although data on JPA use have been positive, JPAs must be fully integrated into a personnel system to achieve maximum effectiveness.

An integrated personnel systems approach can be used to design a career path in which JPAs enable individuals with no formal technical training to be effective members of a shipboard work center. Individuals gain work experience by using JPAs to support task performance; thus, the training can be designed to build upon that experience, and training time can be reduced. In addition, tasks can be grouped, and JPAs can be designed to build upon the training episodes and provide additional on-the-job training (OJT) experience to prepare the individual for the next training episode.

Enlisted Personnel Individualized Career System (EPICS) is a systems approach that jointly considers job design, training, JPAs, career advancement, technical data, personnel organizational management, and personnel resources. Within EPICS, duty at sea precedes formal technical training, which is distributed over an individual's career. Job design is used to determine how tasks within a job specialty can be arrayed over a career such that initial job requirements can be met by using JPAs.

Although a comprehensive test and evaluation is underway for EPICS as a system, an in-depth evaluation on the effectiveness of JPAs within a systems context was not included.

Objective

The primary objective of this effort was to determine if JPAs developed within an integrated personnel system framework and in accordance with the principles of job design (1) would be accepted as a valid form of maintenance documentation and (2) used as a source of maintenance information during task performance by technicians. A secondary objective was to compare the acceptance and use of JPAs by EPICS participants who (1) are eligible and ineligible for the fire control technician (FT) rating (redesignated FC as of July 1985), (2) have high and low aptitude scores, (3) have high and low reading ability, and (4) are assigned to the Atlantic and Pacific fleets.

Approach

Evaluating the effectiveness of JPAs involved collecting attitudinal data, in the form of three questionnaires and a structured interview, from: the EPICS participants, the shipboard administrators, and the work center supervisors. Data analysis varied according to the instrument used.

Results

After EPICS personnel had been onboard ship approximately 15 months, data were collected from 34 work center supervisors, 34 shipboard administrators, and 112 EPICS

participants. The participants were grouped on the basis of their FT eligibility, Armed Forces Qualification Test (AFQT) scores, and reading level. In addition, they were contrasted according to fleet assignment. Findings are summarized according to acceptance, use, and implementation.

1. Acceptance. Shipboard administrators and EPICS personnel assessed the JPAs as well-designed, complete sources of technical information, but shipboard administrators preferred maintenance requirements cards (MRCs) to JPAs. EPICS personnel preferred using JPAs for first time and infrequently occurring tasks, but preferred MRCs for frequently occurring tasks.

2. Use. JPAs were used for all task types, but more for unscheduled than scheduled tasks. The FT-ineligible group used JPAs more often than did the FT-eligible group for scheduled tasks. The lower AFQT score and lower reading-grade-level groups used JPAs more often than did the higher AFQT score and higher reading-grade-level groups for unscheduled tasks.

3. Implementation. Less than 40 percent of the tasks performed included the use of a JPA. Because of apparently better implementation in the Atlantic fleet, the Atlantic fleet EPICS personnel preferred JPAs over MRCs for all task types and used JPAs more than did the Pacific fleet EPICS personnel.

Conclusions

JPAs were accepted and used as a source of technical information during performance of maintenance tasks by EPICS personnel varying in FT eligibility, general aptitude, and reading ability. The JPAs meet the information needs of the lower aptitude/poorer reader participants.

Recommendations

1. Regardless of existing maintenance system guidelines, task frequency in addition to skill and aptitude level of the JPA user should be incorporated as a design criterion for JPA development.

2. The following recommendations for future JPA implementations within an integrated personnel system context are based on experience gained from EPICS:

a. JPAs should not compete with existing support documentation (e.g., MRCs) even if the target audience has no preconceptions about which form of maintenance documentation they prefer.

b. JPAs should be completely installed as support documentation prior to the arrival of the target population.

c. Work center supervisors should support the JPA implementation process.

d. Aptitude, skill level, experience, task frequency, and task difficulty should be integrated into JPAs of differing levels of detail.

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INTRODUCTION

Problem

In the maintenance environment, technicians perform specific maintenance tasks, which are mostly procedural and usually supported with some type of technical documentation. One form of technical documentation that has been shown to be effective is the job performance aid (JPA). JPAs are proceduralized instructions (Figure 1) that have been used to (1) reduce training time, (2) facilitate successful task performance, and (3) increased utilization of inexperienced personnel (Booher, 1977; Rowan, 1973; Shriver & Hart, 1975). However, when JPAs have been added to an existing personnel system without integrating all components of that system, there have been problems in both acceptance and use of JPAs (Johnson, Thomas, & Martin, 1977).

Objective

The primary objective of this effort was to determine if JPAs developed within an integrated personnel system framework and in accordance with the principles of job design (1) would be accepted as a valid form of maintenance documentation and (2) used as a source of maintenance information during task performance by technicians. A secondary objective was to compare the acceptance and use of JPAs by Enlisted Personnel Individualized Career System (EPICS) participants who (1) are eligible and ineligible for the fire control technician (FT) rating, (2) have high and low aptitude scores, (3) have high and low reading ability, and (4) are assigned to the Atlantic and Pacific fleets.

Background

Although initially a JPA was any device that facilitates the performance of a given task, the more restrictive definition now used is a set of step-by-step instructions supported by illustrations providing complete start-to-finish information for performing a given task. The need for JPAs became apparent when effective maintenance performance required too much time and too many resources. Folley (1961) noted that individuals with an average to high general aptitude had to go through extensive training prior to becoming successful maintenance technicians and that technicians had to retain an extensive amount of information in order to perform various tasks. With JPAs, technical information could be presented in a format that (1) reduces training time (Elliott & Joyce, 1971), (2) facilitates performance by decreasing performance time and errors (Elliott & Joyce, 1971; Gebhard, 1970), and (3) allows lower aptitude individuals to complete tasks successfully (Elliott, 1967).

The Air Force conducted one of the most extensive research and development efforts to demonstrate the benefits of JPAs. This study, the Presentation of Information for Maintenance and Operation (PIMO) project (Serendipity, 1969), demonstrated that inexperienced technicians with minimal technical training and experienced specialists performed similar maintenance tasks in about the same time. Although project PIMO and the design specifications that grew out of it were milestones in JPA technology, other elements in the personnel system (e.g., job design, type of training, etc.) were not considered.

By 1977, the Office of the Secretary of Defense, through formal management meetings, determined that there was a need to (1) integrate existing JPA technologies with technical data, training, and personnel support systems and (2) demonstrate the feasibility of an integrated personnel systems approach. As a result, Foley (1978)

13. Position new power supply (15, 16, 18) onto mounting plate (23). Install four screws, lockwashers, and washers (25).

14. Position new power supply (17) onto mounting plate (23). Install six Phillips screws, lockwashers, and washers (26).

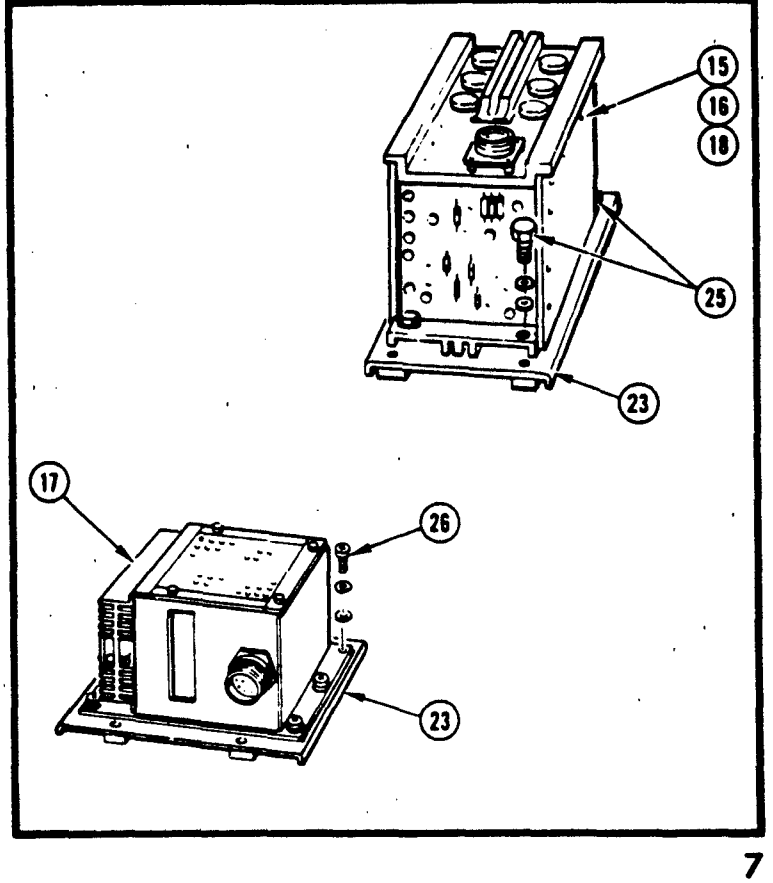

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Figure 1. An example from a job performance aid illustrating the typical format.

emphasized JPA technology in developing a model to provide productive personnel without large front-end training costs. The model, however, did not adequately address job design or its use to structure an individualized career path based upon specific system requirements. One effort that integrated JPA technology with all other elements of a personnel system was EPICS.

EPICS emphasizes the use of job design in the design and development of JPAs (Blanchard & Smillie, 1980). EPICS is the product of an integrated personnel systems approach that considers job design, training, JPAs, career advancement, technical data, personnel organizational management, and personnel resources. Tradeoffs among these seven elements resulted in the development of a six-year model comprising three successive skill levels. The NATO Seasparrow Surface Missile System (NSSMS), which is operated and maintained by FTs, was selected as the test system. Blanchard, Smillie, and Conner (1984) describe the EPICS design, development, and implementation in depth.

EPICS defers formal technical training and distributes it over an individual's career. In addition, job design is used to determine how tasks can be arrayed over the career so that initial job requirements can be met using JPAs.

A task and behavioral analysis determined that two types of JPAs, fully and partially proceduralized, were needed to support maintenance performance. Fully proceduralized JPAs (FPJPAs) were designed for EPICS personnel who were in the first year of their career and had no training or experience in performing the various maintenance tasks. Based on previous research (e.g., project PIMO) FPJPAs were designed as complete, very detailed sets of maintenance procedures that focus on illustrations for the task steps and use brief narrative statements only to support the illustration (Figure 2). Partially proceduralized JPAs (PPJPAs) were designed for EPICS personnel who had approximately one year of shipboard technical experience and some basic electronics training. Thus, PPJPAs relied more heavily on narrative descriptions of task steps. In contrast to the FPJPAs, illustrations were used only for maintenance tasks areas that personnel had not performed many times during their first year in the Navy (Figure 3).

The comprehensive test and evaluation designed for EPICS as a system (Blanchard, Clelland, & Megrditchian, 1984) did not include an in-depth evaluation of JPA effectiveness within the system's context. Specifically, while JPAs have been shown to be effective adjuncts to existing technical documentation and training for fielded systems, how JPAs will be accepted and used when developed in accordance with an integrated personnel system is not known.

APPROACH

Subjects

After EPICS personnel had been onboard ship approximately 15 months, data describing various characteristics of JPAs were collected from EPICS participants, shipboard administrators, and work center supervisors. The 112 EPICS participants were aboard 34 ships, had recently completed the first skill level in the EPICS career path (apprentice technician duty), had JPAs available as guidance for scheduled and unscheduled maintenance tasks, and had completed the shipboard training phase prior to attending the first shore-based school. Of these 112, 27 were interviewed, 110 responded to the feedback survey, 70 completed the JPA usage survey, and 45 were rated by their work center supervisor. Most of the EPICS personnel had been in the Navy approximately 16

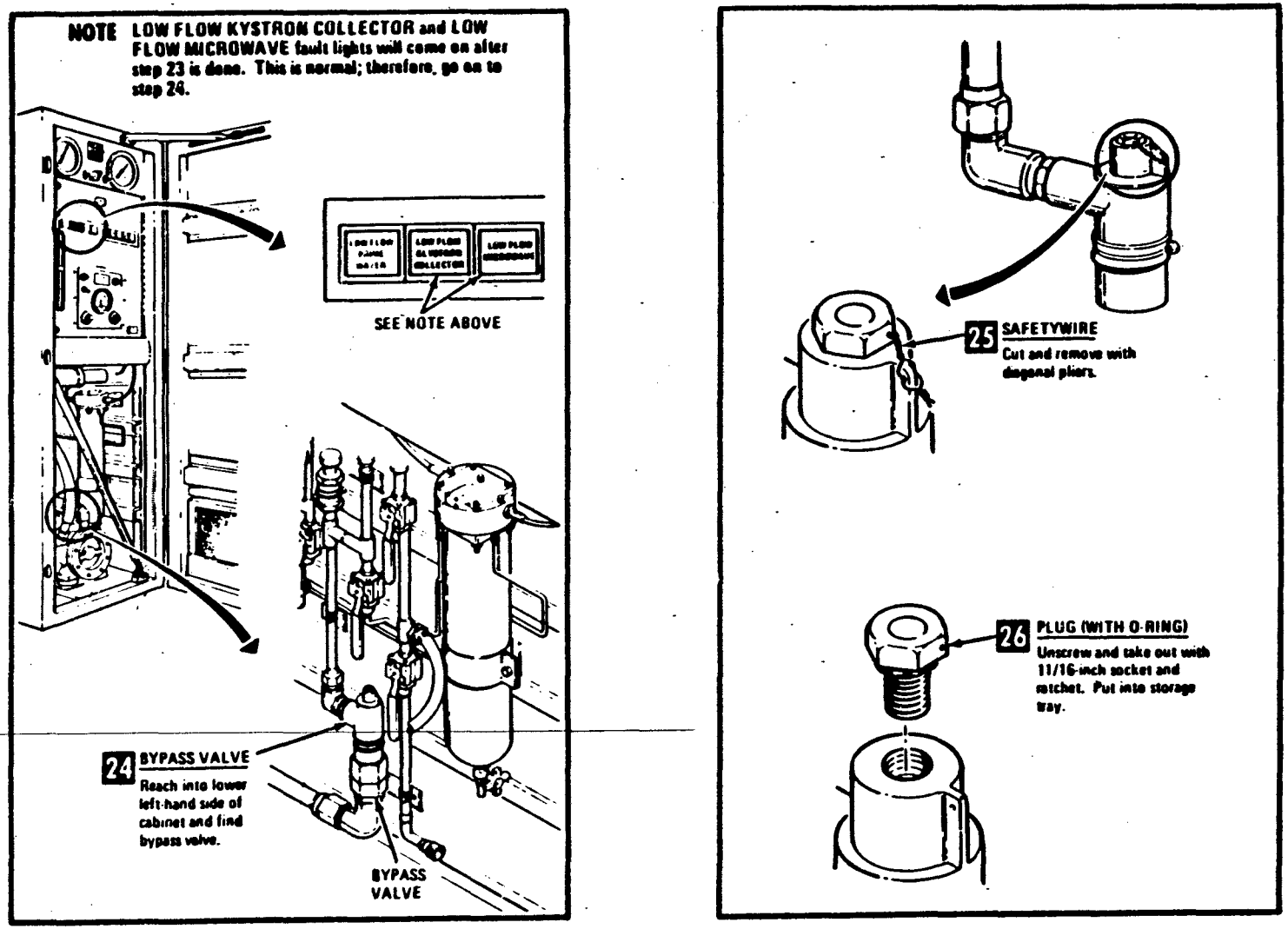
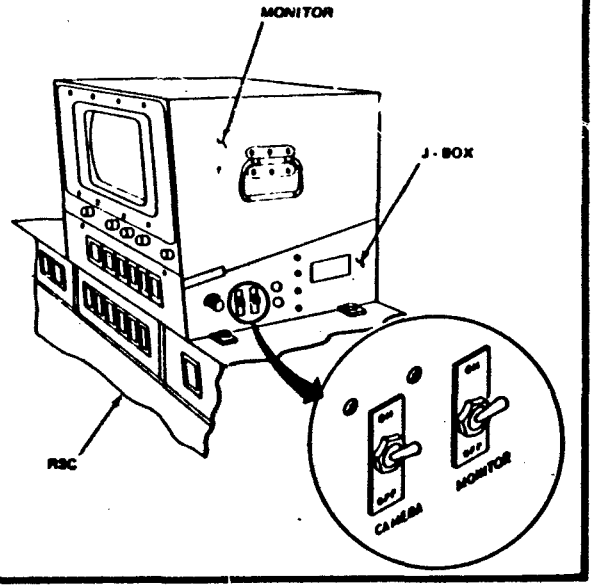


Figure 2. An extract from an EPICS fully proceduralized JPA (FPJPA).

PROCEDURES

NOTE This JPA contains procedures for focusing the LLLTV monitor. To perform this task, three potentiometers, located inside the rear of the monitor, are adjusted.

1. At Junction Box (J-Box) set CIRCUIT BREAKERS-CAMERA and MONITOR to ON.



2. At LLLTV control panel on the Radar Set Console, set SYSTEM STATUS-POWER to ON.

3. At LLLTV, set CROSS HATCH-OFF/ON to ON.

4. At front of J-Box, verify that CAMERA FAULT and MONITOR FAULT indicators are not lit.

5. At rear of monitor, remove 13 captive screws holding PWA panel to monitor using flat tip screwdriver; raise PWA panel.

6. Locate the following three potentiometers adjustments on the FOCUS BLANKING card (color coded yellow) (A5), (the names are placarded inside the PWA panel):

   a. R38 - FOCUS ADJ
   b. R7 - LINE DYNAMIC FOCUS ADJ
   c. R26 - FIELD DYNAMIC FOCUS ADJ

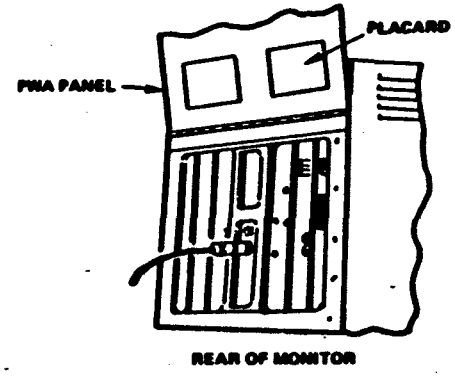


Figure 3. An extract from an EPICS partially proceduralized JPA (PPJPA).

months and ranged in pay grade from E-2 to E-4. Table 1 provides demographic characteristics of each group of respondents.

Table 1

Demographic Characteristics for EPICS Respondent Groups

EPICS Group	Demographics										
	Ships (N=34) (%)	Fleet[a] A (%)	Fleet[a] P (%)	FT Eligibility[b] E (%)	FT Eligibility[b] I (%)	AFQT[c] Score $\bar{X}$	AFQT[c] Score SD	Reading Grade Level $\bar{X}$	Reading Grade Level SD	Education Level (Years) $\bar{X}$	Education Level (Years) SD
Total[d] (N=112)	100	51	49	52	48	66	17.3	11	1.8	12	.8
Interviews (N=27)	38	58	42	--	--	--	--	--	--	--	--
Feedback Survey (N=110)	100	50	50	52	48	66	17.2	11	1.9	12	.8
JPA Usage Survey (N=70)	79	70	30	43	57	64	17.8	11	1.8	12	.6
Supervisor Confidence Ratings (N=45)	68	71	29	56	44	63	18.2	11	1.7	12	.7

[a]A = Atlantic fleet; P = Pacfic fleet.

[b]E = eligible for fire control technician rating; I = ineligible for FT rating.

[c]AFQT = Armed Forces Qualification Test; $\bar{X}$ = mean.

[d]Total number of EPICS personnel completing apprentice technician duty (have received no formal shore-based training).

Of the 34 shipboard administrators, 10 were interviewed and 17 responded to the feedback survey. To preserve anonymity, few personal demographics were obtained from the shipboard administrators. Most had been in the Navy 4 to 5 years and were generally E-5s, although a few were more senior.

The 34 work center supervisors were requested to rate their confidence in EPICS personnel; 29 completed rating forms for 45 EPICS personnel. Demographics on the supervisors were similar to those of the shipboard administrators.

Instruments

Four different instruments were developed to obtain data: feedback surveys, JPA usage survey, supervisor confidence ratings, and structured interviews. These instruments provided information on JPA acceptance and use. Table 2 provides the sample size and response rate for each measurement instrument.

Table 2

Variable/Measure Relationships and Measure Response Rates

Variables	Measure	Sample Size	Response Rate[a] (%)
Acceptance	EPICS personnel feedback survey	110	98
	Shipboard administrator feedback survey	17	50
	JPA usage survey	70[b]	62
	EPICS personnel interviews	27	24
	Shipboard administrator interviews	10	29
Use	JPA usage survey	70[b]	62
	Supervisor confidence ratings	45[c]	40

[a]EPICS personnel return rates are based on total N = 112; shipboard administrator response rates on total N = 34.

[b]Only EPICS personnel completed the JPA usage survey.

[c]This sample size is based on the number of EPICS participants for whom both supervisor rating data and JPA usage data were available.

1. Feedback surveys. As part of the overall evaluation of EPICS, a series of feedback surveys was developed to assess the attitudes of EPICS personnel and shipboard administrators. Only responses related to JPA items are reported here. (Blanchard, Clelland, & Megrditchian, 1984), summarize the data on other EPICS variables.) The JPA questions on the feedback survey addressed JPA acceptance: Shipboard administrators were given 9 questions and EPICS sailors were given 16 questions. Each question started with "To what extent" and had a 5-point Likert response scale. The scale ranged from 1 (very little extent) to 5 (very great extent).

2. JPA usage survey. The JPA usage survey was administered to EPICS personnel when they arrived at their first school, equipment technician training (ETT). The survey consisted of six questions on JPA acceptance and listed the 198 tasks for which JPAs had been developed. Since both JPAs and maintenance requirement cards (MRCs) were available for these tasks, the questions asked which type of maintenance documentation the EPICS personnel prefer. (An MRC is an abbreviated checklist with no illustrations.)

For the task listing, respondents were instructed to estimate the number of times they had performed each task and the number of times they had used a JPA to perform each task. Although the usage survey provided some information on JPA acceptance, its primary use was to obtain information on the frequency of JPA use. Table 1 shows 70 percent of those responding to the JPA usage survey were assigned to the Atlantic fleet, approximately 20 percent more than in the initial EPICS cohort distribution (Blanchard, Smillie, & Conner, 1984, Table 3, p. 10).

3. Supervisor confidence ratings. Supervisor confidence ratings rated the degree of confidence a supervisor had in the ability of EPICS personnel to perform maintenance tasks. Supervisor confidence was assumed to be related to JPA use. The following technical areas that are relevant to JPA usage were rated: (a) clean, inspect, and lubricate tasks, (b) remove and replace tasks, (c) system tests, (d) adjustment of system components, (e) ordnance handling, (f) fault isolation, and (g) operator tasks. EPICS shipboard administrators were instructed to rate their confidence in each EPICS participant in performing each task according to the degree of assistance required. The scale used ranged from 1 (not at all confident; always required assistance) to 5 (extremely confident; never required assistance) with 0 (not observed, so cannot assess) and 9 (participant has not performed) also possible. The data were collected when the EPICS personnel completed apprentice technician duty. As with the JPA usage survey, 71 percent of those responding were assigned to the Atlantic fleet (see Table 1).

4. Structured interviews. Structured interviews of both EPICS personnel and shipboard administrators covered a variety of topics including preference for JPAs or MRCs as the technical documentation to support shipboard maintenance. Only the JPA and MRC related responses are reported here.

Analysis

Data were collected only for the initial EPICS skill level, where FPJPAs are supposed to be used, and not for the advanced skill levels, where PPJPAs are supposed to be used. Consequently, the data are only representative of FPJPAs.

Descriptive statistics were computed for both shipboard administrators and EPICS personnel on the feedback survey items related to acceptance. Response percentages were computed for each point of the 5-point survey scale. Data from the EPICS personnel were grouped according to the following four variables and t-tests were computed to test for differences between groups: (1) FT eligibility, (2) AFQT score, (3) reading grade level, and (4) fleet assignment.

Eligibility for the FT rating is based on a composite score of specific subtests on the Armed Forces Vocational Battery (ASVAB). Individuals with a composite score of 218 or greater are eligible to become FTs; those with less than 218 are ineligible.

AFQT is a general aptitude screening criterion that is based on a different composite score of subtests on the ASVAB. Data were collected from 40 EPICS personnel with a low AFQT score (less than or equal to 60) and 30 with a high AFQT score (more than 60).

Reading grade level is defined as a measure of reading ability as determined by the Gates-McGinitie Reading Test. Data were collected from 25 participants with a low reading grade level (below grade 11) and from 44 with a high reading grade level (grade 11 or above).

Fleet assignment is the fleet command of ships to which the EPICS personnel were assigned. Data were collected from 49 personnel assigned to the Atlantic fleet and 21 assigned to the Pacific fleet.

FT eligibility was used to divide EPICS personnel to determine any differences in acceptance and use of JPAs between the FT-eligible and FT-ineligible groups. AFQT scores were used to determine if the results categorized according to the electronics aptitude measure were similar to this more general aptitude measure. Since the users had to "read" material in the JPA, reading grade level measures were used to determine if acceptance and use of JPAs by good and poor readers differed. EPICS personnel were assigned to the Pacific fleet approximately 6 months prior to those assigned to the Atlantic fleet. Comparisons between the two fleets were made to determine if differential JPA acceptance or use would result from implementation variations.

Response percentages were computed for the EPICS personnel on the six usage survey questions related to JPA acceptance. Chi square values were also computed to contrast groups on each of the four variables.

The usage survey was designed to provide performance information on the 198 tasks for which JPAs had been developed. Tasks were grouped into two categories, scheduled and unscheduled. Scheduled tasks are preventive maintenance tasks (cleaning, adjusting, testing) that are performed periodically (e.g., weekly, monthly). Unscheduled tasks, on the other hand, are corrective maintenance tasks (remove, replace) that are performed aperiodically (i.e., when required). From a total of 198 possible tasks, 42 were never performed. Table 3 shows the number of tasks in each category.

Table 3

Number of Tasks by Performance Category

Task Category	Performed	Never Performed	Possible
Scheduled	46	0	46
Unscheduled	110	42	152
Total	156	42	198

Although technical documentation, such as JPAs, is available, it is not always used when a maintenance task is performed. For example, technicians who have performed a particular task a number of times in the past may be confident that they can presently perform the task without referring to the documentation. Since MRCs were also available, technicians may never use a JPA for a particular task. Therefore, a usage ratio (JPA frequency/task frequency) was computed for each task an individual had performed. Usage ratios were then summed across tasks within each of the task categories. Then, an average usage ratio was computed for each task category. For example, a value of 0.5 or 50 percent indicates that EPICS personnel used a JPA one out of every two times they performed a particular task.

In order to account for the tasks for which JPAs were never used, two usage ratios were computed.

1. Implementation (IMP) usage ratios were computed for all tasks that EPICS personnel reported they had performed at least once. For example, if an individual performed one scheduled task 5 times and another scheduled task 20 times, all 25 times were counted regardless of whether JPAs had been used. If the individual did not use a JPA on the first task and used a JPA 10 times for the second task, the IMP value for those two tasks would be (0 + 10)/(5 + 20) or 40 percent. High IMP values would indicate that JPAs were perceived as a part of the official maintenance documentation system.

2. Specific JPA usage (USE) ratios were computed only for tasks for which JPAs had been used at least once. Using the same example as for IMP, the USE ratio would be (10/20) or 50 percent. The task performed five times without using the JPA does not enter into the calculations. High USE ratios indicate that the personnel who used the JPAs consider them to be essential aids for performing maintenance. To determine if USE raios would be influenced by FT eligibility, AFQT score, or reading grade level, a one-way analysis of variance was computed for each. USE ratios were selected as indicators of JPA usage because the reasons that JPAs were never used for given tasks could not be determined. In fact, it was quite likely that no documentation--neither JPAs nor MRCs--was used for some tasks.

Pearson correlations were computed between supervisor confidence ratings of the EPICS personnel and the JPA usage measure (USE ratio) for the following technical task areas: (1) clean, inspect, and lubricate tasks, (2) remove and replace tasks, (3) system tests, and (4) adjustment of system components. Data were gathered from 34 work center supervisors.

Interview data were content analyzed for all information referring to some aspects of JPAs. These comments were then categorized according to common themes.

RESULTS

Acceptance

Although the feedback survey had a 5-point scale to allow respondents a range for responses, the two upper and lower response categories were collapsed to facilitate survey data interpretation. Tables 4 and 5 provide the response percentages of the EPICS shipboard administrators and the EPICS personnel respectively for each response category as well as the means and standard deviations (SD) of the 5-point scale. The t-tests that were run of the means for the various EPICS personnel groupings (Table 5) revealed significant differences between personnel:

1. With low and high AFQT scores for Question 16, $t(17) = -2.3$, $p < .05$.
2. With low and high reading grade levels for Question 9, $t(89) = -2.6$, $p < .05$.
3. With low and high reading grade levels for Question 13, $t(17) = 3.2$, $p < .01$.
4. Assigned to the Atlantic and Pacific fleets for Question 1, $t(108) = -2.7$, $p < .01$.

5. Assigned to the Atlantic and Pacific fleets for Question 7, $t(17) = 2.2$, $p < .05$.

6. Assigned to the Atlantic and Pacific fleets for Question 10, $t(108) = -2.1$, $p < .05$.

Table 4

EPICS Shipboard Administrator Responses on JPA Design

Question (N=17)	Response Category (%) Very Little/ Little	Some	Great/ Very Great	Mean (5-point scale)	SD
To what extent . . .					
1. do you have to assist EPICS sailors when they use JPAs?	70	18	12	2.1	1.0
2. do EPICS sailors find JPAs easy to follow?	--	12	88	4.4	.7
3. are there errors in JPAs?	59	35	6	2.1	1.0
4. do JPAs contain all the information for the job?	6	18	76	3.9	.8
5. is it necessary to have training in the use of JPAs?	64	29	7	2.2	1.3
6. do EPICS sailors use MRCs when JPAs are available?	12	18	70	3.8	1.0
7. does having JPAs make you more confident in assigning EPICS sailors?	58	24	18	2.4	1.1
8. are the JPAs overly simplified?	6	29	65	4.1	1.0
9. would you be satisfied with JPAs for all maintenance?	94	--	6	1.4	1.0

Table 5

EPICS Personnel Responses on JPA Design

Question	N	Response Category (%) Very Little/ Little	Some	Great/ Very Great	Mean (5-point scale)	SD
To what extent . . .						
1. do you need help when using JPAs?	110	87	9	4	1.6	.8
2. do JPAs contain all the information for a job?	110	4	26	70	3.8	.9
3. are you asked to show EPICS people how to use JPAs?	19	67	24	9	1.9	1.0
4. are JPAs easily lost?	19	100	--	--	1.5	.5
5. do you have difficulty getting JPAs?	19	68	23	9	2.1	1.2
6. do JPA pages get lost, torn, or dirty?	19	96	4	--	1.4	.6
7. are JPAs easy to handle while working?	19	15	45	40	3.2	1.0
8. is it necessary to have training in the use of JPAs?	110	84	10	6	1.7	.9
9. are you asked to show others how to use JPAs?	91	74	15	11	1.9	1.1
10. are the JPAs hard to understand?	110	92	6	2	1.5	.7
11. are the JPAs correct?	110	10	38	52	3.4	.9
12. are the JPA pictures hard to follow?	110	86	11	3	1.6	.8
13. are the JPAs overly simplified?	19	36	40	24	2.8	1.0
14. would you be satisfied using JPAs for all maintenance?	110	37	40	23	2.7	1.2
15. would you want to have JPAs if you changed jobs?	110	26	48	26	3.0	1.0
16. do JPAs help you become a useful member of your work center?	19	28	20	52	3.2	1.2

Table 6 gives the responses of EPICS personnel to the first four questions of the JPA usage survey. These questions are related to JPA preference (i.e., how well the EPICS participants liked the JPAs). Only one significant statistical difference was found between EPICS personnel assigned to the Atlantic and Pacific fleets for infrequently occurring tasks (Question 4), chi square = 7.2, $p < .05$).

Table 6

EPICS Personnel Responses on JPA Preference

Question	N	Response (%)[a] Yes for Most Jobs	Yes for Some Jobs	No, I prefer to use an MRC
1. Do you like to use a JPA the first time you do a scheduled maintenance task?	69	33	44	22
2. Do you like to use a JPA the first time you do an unscheduled maintenance task?	69	47	34	16
3. Do you like to use JPAs for frequently occurring maintenance tasks?	69	6	23	70
4. Do you like to use JPAs for infrequently occurring maintenance tasks?	69	46	34	17

[a] 1 to 3 percent did not respond.

Specific comments related to JPA acceptance from the open-ended questions of the interview and JPA usage survey were grouped according to whether they were stated in terms of advantages or disadvantages of JPAs. Table 7 provides representative samples of EPICS shipboard administrator comments; Table 8 representative samples from the EPICS personnel. Table 9 summarizes the responses from the two open-ended questions of the JPA usage survey.

Use

Results from the JPA usage survey are grouped according to whether or not the tasks were scheduled. Forty-six scheduled tasks were performed 13,510 times with JPAs used 4,086 times. Similarly, 110 unscheduled tasks were performed 3,042 times with only 88 performed using JPAs--for a total of 721 times.

Table 7

EPICS Shipboard Administrator Interview Responses

Advantages of JPAs
1. Personnel can use JPAs to provide location information and maintenance procedures for areas that are unfamiliar to them. (N=10)
2. Good for infrequently occurring tasks or when unfamiliar with a particular task. (N=5)
3. Excellent for location information. (N=3)
Disadvantages of JPAs
1. Too simple. (N=9)
2. JPAs arrived after the EPICS sailors; used MRCs instead. (N=7)

Table 8

EPICS Personnel Interview Responses

Advantages of JPAs
1. They're great when you first come aboard. (N=15)
2. Location illustrations help when not familiar with equipment. (N=12)
3. Could have gotten along without them initially, but would have required much more supervision. (N=11)
4. Use JPAs the first couple of times to do a task and until I feel confident enough to use MRC. (N=3)
Disadvantages of JPAs
1. JPAs did not arrive until 2 to 3 months after we were using MRCs. (N=4)
2. Didn't need them; always had someone supervising us the first couple of times. (N=4)

Table 9

EPICS Personnel Responses to Open-ended Questions of JPA Usage Survey

What are your reasons for using a JPA instead of an MRC for a task?
1. When doing a task for the first time or unfamiliar with the equipment. (N=13)
2. Do not always understand what has to be done after reading the MRC; the JPA shows the steps that have to be done. (N=10)
3. On difficult tasks; the JPA is more detailed; less likely to make any mistakes. (N=7)
4. JPAs explain things better. (N=7)
5. JPAs are used with MRCs for a better understanding of the task. (N=7)
6. JPA will make the MRC easier to understand if it is a difficult task. (N=5)
7. Sometimes can't get senior people to show where something is located; the JPAs do. (N=3)
8. Don't know enough about the task. (N=3)
9. When doing an infrequent or difficult task, the JPAs leave little room for error. (N=2)
10. MRCs are hard to understand when doing a task the first time. (N=1)
11. JPAs keep the task sequence organized. (N=1)

What are your reasons for using an MRC instead of a JPA for a task?
1. If you are already familiar with the procedures for a particular task, using an MRC is faster. (N=12)
2. MRC is quicker, cuts down to the basic steps. (N=11)
3. For many tasks, an MRC has enough information on it to complete the task. (N=7)
4. On less complicated tasks, an MRC is better because it doesn't give you unnecessary information. (N=6)
5. Most times when JPAs are not used, a petty officer was usually verbally instructing while reading from the MRC. (N=5)
6. MRCs are easier to read and understand than JPAs. (N=5)
7. Already using MRCs when JPAs arrived. (N=5)
8. For many tasks, the JPAs are too simple. (N=4)

Figure 4 gives the IMP ratios for the scheduled and unscheduled tasks. The number of respondents who performed each task group is also given. Figure 5 breaks down the IMP values by fleet assignment. One-way analyses of variance were computed. The only significant differences were between EPICS personnel assigned to the:

1. Atlantic and Pacific fleets for scheduled tasks $F(1, 68) = 7.2$, $p < .01$.

2. Atlantic and Pacific fleets for unscheduled tasks $F(1, 68) = 5.8$, $p < .05$.

Figure 6 gives the overall USE ratios for scheduled and unscheduled tasks. Figures 7 through 9 break down the USE by FT eligibility, AFQT score, and reading grade level. One-way analyses of variance were computed. The only significant differences in USE ratios were found between:

1. FT-eligible and FT-ineligible personnel for scheduled tasks $F(1, 59) = 5.6$, $p < .05$.

2. Personnel with low and high AFQT scores for scheduled tasks $F(1, 59) = 8.8$, $p < .05$.

3. Personnel with low and high AFQT scores for unscheduled tasks $F(1, 42) = 4.5$, $p < .05$.

4. Personnel with low and high reading grade levels for unscheduled tasks $F(1, 42) = 2.6$, $p < .05$.

Table 10 provides the correlation coefficients between supervisor confidence ratings and JPA USE ratios by group and technical task area.

DISCUSSION

Although the primary purpose of this study was to assess how well maintenance technicians accept and use JPAs, information was also obtained on how well the JPAs were integrated into the NSSMS maintenance documentation. Thus, the discussion is divided into three parts:

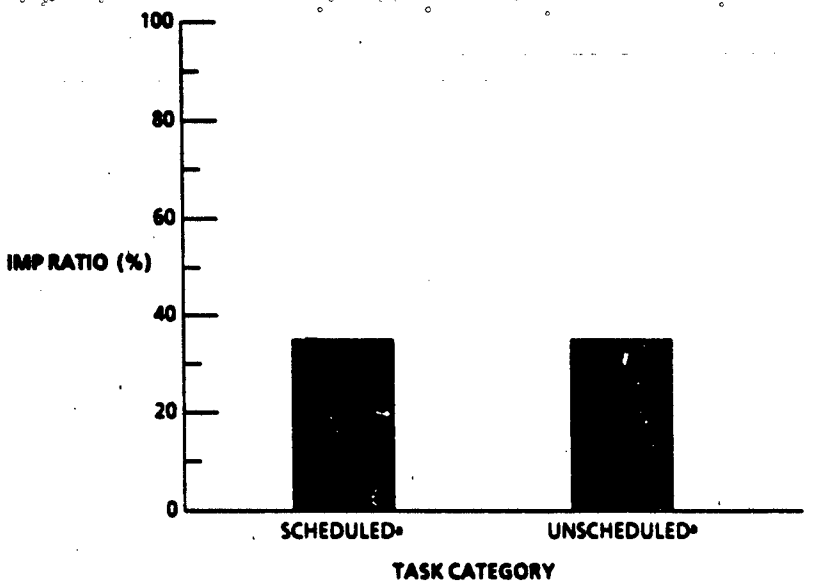
1. Acceptance.

2. Use--the degree to which JPAs were used for particular tasks.

3. Implementation--the degree to which JPAs were implemented as part of the Navy maintenance system.

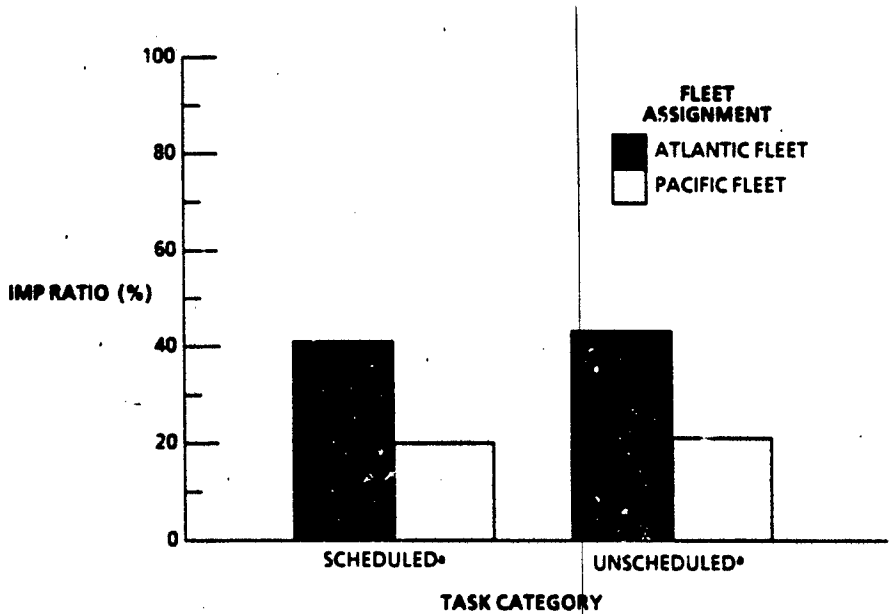
Acceptance

The majority of EPICS shipboard administrators indicated that the JPAs were easy for EPICS participants to follow (88%), contained few errors (59%), contained all the information to do the job (76%), and did not require much training to be used (64%) and that EPICS personnel did not require much assistance when performing a task using JPAs (70%). On the other hand, the majority of shipboard administrators (70%) stated that EPICS personnel prefer to use the conventional documentation--MRCs--rather than JPAs for a given task (70%), they were not more confident in assigning EPICS personnel with JPAs (58%), JPAs were overly simplified (65%), and they would not be satisfied having to use JPAs for all maintenance (94%).



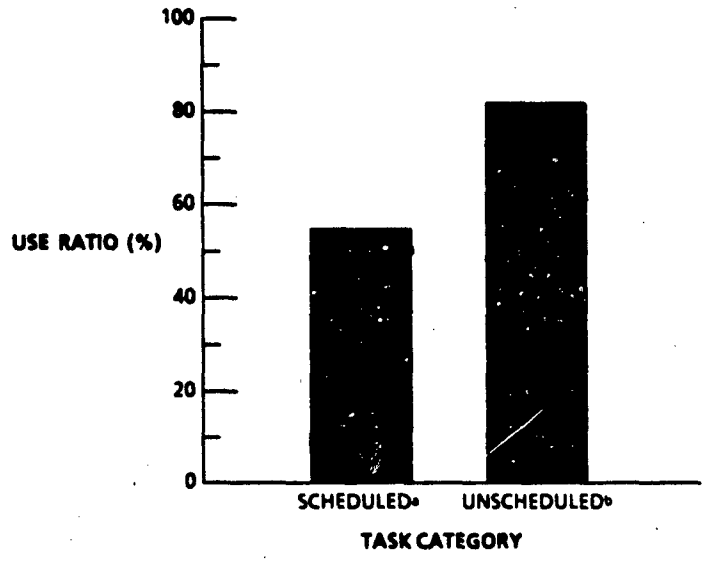
[a]Performed by 70 EPICS participants.

Figure 4. Overall JPA implementation (IMP) ratios by task category.



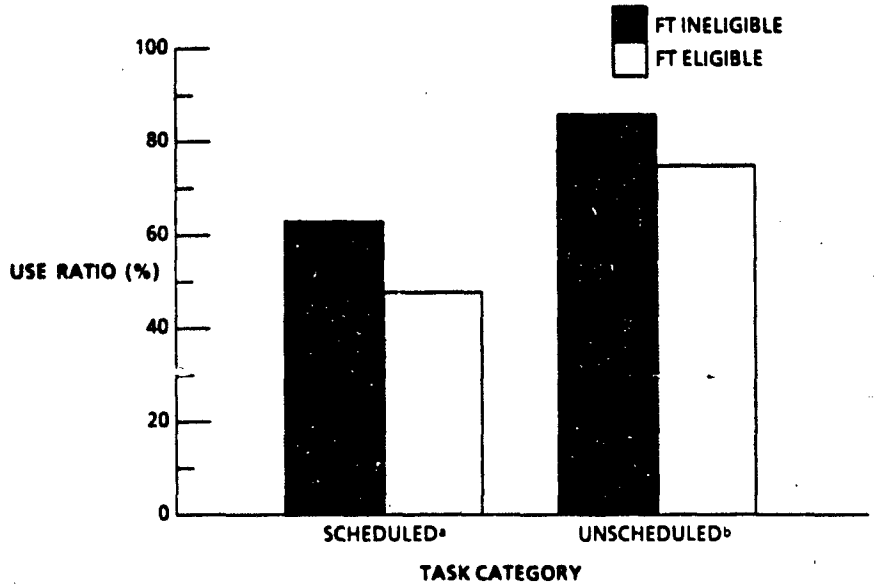
[a]Performed by 49 Atlantic fleet and 21 Pacific fleet EPICS participants.

Figure 5. IMP ratios by fleet assignment and task category.



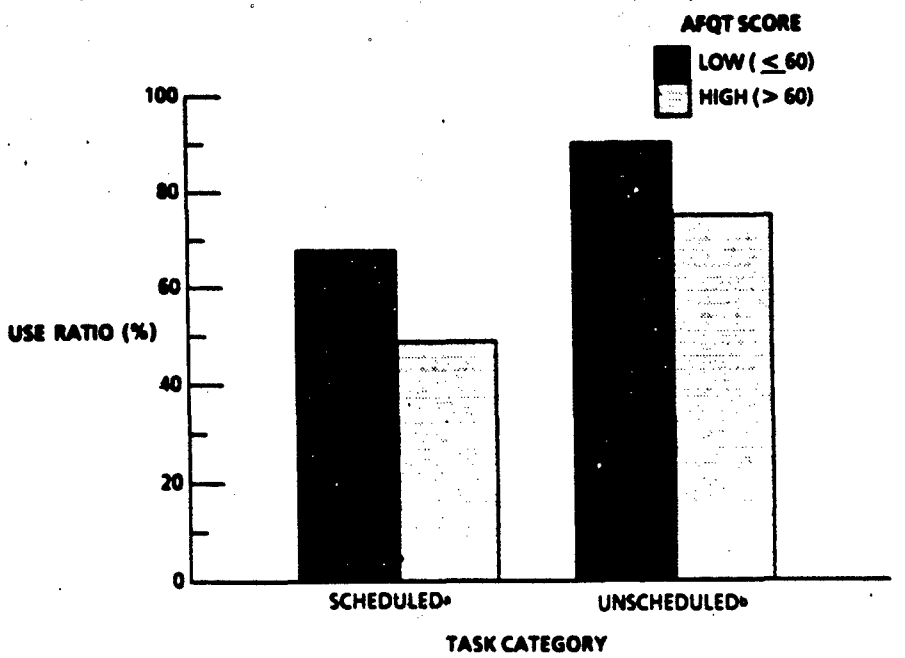
[a]Performed by 61 EPICS participants.
[b]Performed by 44 EPICS participants.

Figure 6. USE ratios by task category.



[a]Performed by 35 FT-ineligible and 26 FT-eligible EPICS participants.
[b]Performed by 25 FT-ineligible and 19 FT-eligible EPICS participants.

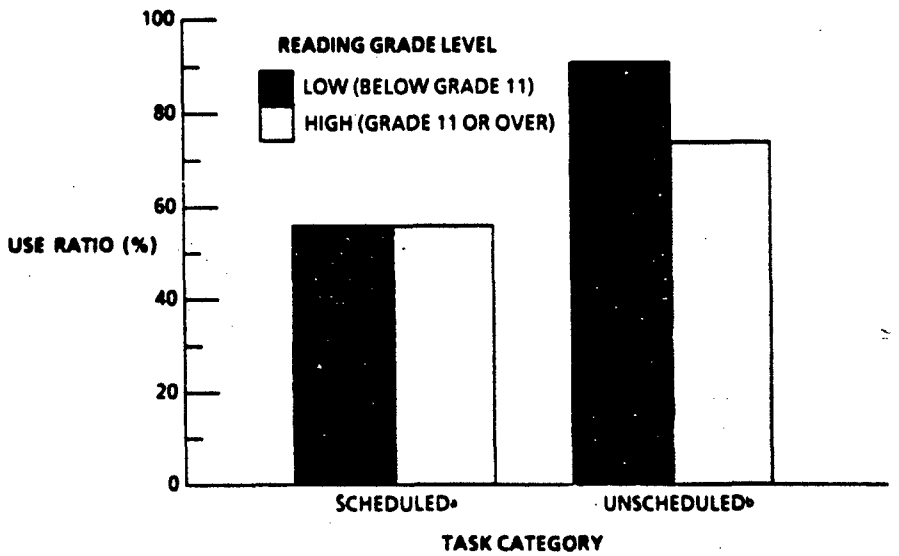
Figure 7. USE ratios by FT eligibility and task category.



[a]Performed by 25 EPICS participants with low AFQT scores and 36 with high AFQT scores.

[b]Performed by 18 EPICS participants with low AFQT scores and 26 with high AFQT scores.

Figure 8. USE ratios by AFQT scores and task category.



[a]Performed by 22 EPICS participants with low reading grade levels and 39 with high reading grade levels.

[b]Performed by 18 EPICS participants with low reading grade levels and 26 with high reading grade levels.

Figure 9. USE ratios by reading grade level and task category.

Table 10

Correlation Coefficients Between Supervisor Confidence Ratings and JPA USE Ratios

Task Group	Technical Task Area			
	Clean and Inspect	Remove and Replace	System Tests	Adjustment
Scheduled	-.39* (N=38)	-.12 (N=27)	.12 (N=38)	-.23 (N=29)
Unscheduled	-.10 (N=28)	.24 (N=22)	.10 (N=28)	.08 (N=22)

*p = < .01.

While the shipboard administrators were divided in their overall acceptance of JPAs, the EPICS personnel's acceptance was generally positive or at least ambivalent. Comparing the answers to two questions that were the same for both the shipboard administrators and the EPICS personnel, only 24 percent of the EPICS personnel stated that the JPAs were overly simplified and only 37 percent would be dissatisfied with using JPAs for all maintenance, while the shipboard administrators answered 65 and 94 percent respectively. This difference in responses is not surprising considering that the EPICS personnel were inexperienced technicians and were less likely to resist changing from MRCs to JPAs.

In comparing the feedback survey responses of the groups of EPICS personnel, there were some differences. The low AFQT score group was more positive about the JPAs helping them become useful members of the work center. The low reading grade level group (1) was asked least often to show others how to use JPAs and (2) was less negative about the JPAs being overly simplified. Johnson et al. (1977) also found that JPA acceptance was greater among personnel with lower skill levels.

Regarding the type of maintenance tasks for which EPICS personnel would like to use JPAs, 77 percent like to use JPAs the first time they do some/most scheduled tasks; 81 percent liked using JPAs the first time they do an unscheduled task; and, although 80 percent prefer to use JPAs for at least some infrequently occurring maintenance tasks, 70 percent favored using a more abbreviated checklist format such as the MRC for frequently occurring tasks. Thus, in general, the EPICS personnel preferred using JPAs for first time and infrequently occurring tasks but preferred MRCs for frequently occurring tasks.

The decision to make the JPAs compatible with the Navy maintenance system may have influenced the results. The Navy maintenance system requires documentation for all scheduled tasks. In contrast, guidelines (Joyce, Chenzoff, Mulligan, & Mallory, 1973) derived from JPA research state that there should be a tradeoff between the maintenance tasks supported with JPAs and the tasks supported with training. For scheduled tasks in the the EPICS program, it was decided to develop JPAs that are compatible with the Navy maintenance system even if the task was more suitable for training. Thus, the excessive detail of the JPAs may indeed provide all the information necessary to perform tasks correctly the first time, but continued exposure to such detail for the frequently

occurring scheduled tasks distracts the users. Besides conforming strictly to the JPA/training tradeoff, another method of providing complete information in a more acceptable format is to use a multilevel JPA. A multilevel JPA presents all the information an inexperienced technician might need in a format that also allows an experienced technician to use the JPA as a checklist (e.g., by highlighting critical steps). The problem is then one of cost/benefits; that is, can the additional development cost be justified?

EPICS personnel may also prefer MRCs over JPAs for frequent tasks because of the redundancy across similar tasks. For example, all the JPAs for a particular cabinet contain the same access and close-up procedures. These portions could be removed from the JPAs and placed into a single shipboard instruction module to eliminate the constant redundancy. An integrated personnel system such as EPICS has this additional opportunity for the JPA/training tradeoff.

These results also agree with those of Johnson et al. (1977) for the frequently occurring tasks; that is, abbreviated checklists are preferred over more detailed JPAs. For both first time unscheduled and infrequently occurring tasks, however, Johnson et al. found that the less skilled Air Force technicians liked JPAs better than did the more skilled technicians. This difference is not very evident in the present study. In the Air Force study, the definition of skill level appears to be a composite of ability, training, and experience. All EPICS personnel regardless of aptitude (AFQT score) or FT eligibility (composite ASVAB score) had the same training and experience.

The open-ended responses of the shipboard administrators and EPICS personnel support the survey responses and provide some insight into their specific likes and dislikes. The shipboard administrators stated that JPAs provide good location information, but the format is too simple. The EPICS personnel also stated that JPAs (1) were useful for performing the task initially, (2) provide helpful location information, and (3) organized the technical information better and provided better understanding of the task than the MRCs. Negative comments from the EPICS personnel on the use of JPAs were directed at the frequent or familiar tasks. Availability of only detailed JPAs for frequently occurring tasks, as well as problems in implementation may have contributed to the negative comments; the reasons for these will be discussed in the Implementation section.

Use

While measures of acceptance are used to determine why a JPA is or is not used, measures of actual use (the USE ratios in this study) provide information on how and under what circumstances a JPA is used. For scheduled tasks, JPAs were used 58 percent of the time and, for unscheduled tasks, JPAs were used 81 percent of the time. Unfortunately, there was no way of determining if the USE value for the scheduled tasks was a result of heavy JPA usage for first time tasks only, with little or no JPA usage for repeat tasks. According to the acceptance data, individuals preferred not to use JPAs on subsequent performances of frequently occurring tasks. On the other hand, the JPA usage measures for unscheduled tasks support the acceptance findings of individuals preferring to use JPAs for infrequently occurring tasks (most unscheduled tasks have long intervals between tasks). The high JPA usage also appears to support the acceptance finding of using a JPA the first time a task is performed.

To determine if the FT eligibility affects the use of JPAs (Figure 7), it is important to note that FT ineligibles always used JPAs more than the FT eligibles (63% for scheduled tasks and 86% for unscheduled tasks compared to 48% and 75% respectively).

Only the difference between scheduled tasks, however, was significant. The FT eligibles also rated the JPAs as easy to use and understand. These findings support the assumption that JPAs were designed to ensure that individuals who did not meet the FT-eligibility criteria (i.e., with ASVAB composite scores below 218) would be able to perform maintenance using the JPAs.

While FT ineligibles used JPAs more, there was no similar finding for acceptance. The apparent discrepancy between JPA use and acceptance for infrequently occurring tasks is not surprising. The JPAs were designed to accommodate individuals who were not eligible for the FT rating. They would need the more detailed technical information in the JPAs even after performing a maintenance task for the first time. On the other hand, with two levels of detail available for the required technical information, the FT-eligible personnel would be better able than the FT-ineligible group to use the less detailed MRCs on subsequent performances of maintenance tasks. At the same time, the FT-eligible group recognized their need for the more detailed JPAs for infrequently occurring tasks.

Results on JPA use for the groups with high and low AFQT scores (a general measure of aptitude) were similar to those of the FT-eligibility groups. Individuals with the low AFQT scores used JPAs more than individuals with the high AFQT scores (Figure 8). However, unlike FT eligibility, the comparison between the low and high AFQT score groups was significant for both scheduled and unscheduled tasks.

For reading grade level, only the difference for the unscheduled tasks comparison was significant and consistent with the findings for both FT eligibility and AFQT score. From the past research on JPAs, it was assumed that JPAs with many pictorials would permit individuals who did not read well to complete a given task successfully. It was further assumed that, because of the use of many pictorials, individuals with low reading grade levels would prefer the JPA format regardless of task type. This assumption was true only for unscheduled tasks.

Supervisor ratings were correlated with the JPA usage measure for scheduled and unscheduled tasks because a relationship was predicted between the confidence a supervisor has in an individual and the percentage of time the individual used JPAs (Table 10). The negative correlation between the scheduled tasks and the supervisor confidence rating for the clean and inspect task (i.e., the scheduled task; $r = -.39$, $p < .01$) was the only statistically significant coefficient. This indicates that supervisors have little confidence in an individual who uses JPAs a lot (i.e., the supervisor tends to view JPAs as unnecessary for scheduled tasks). An alternative explanation is that supervisors consider the use of JPAs as a necessary first step, but they believe that to become a competent technician, an individual must go beyond the maintenance support documentation and understand the purpose for doing preventive maintenance. Thus, a technician still using JPAs may be perceived as lacking in technical ability. The availability of a JPA with multiple levels of detail may give rise to different confidence ratings.

Another explanation for the negative correlation is that supervisors associated high use of JPAs with lower aptitude personnel and that they were aware of this association. The shipboard administrators' response to a similar feedback survey item--58 percent had little confidence in assigning EPICS personnel who use JPAs--supports either interpretation. The fact that these correlative data are only from a small sample precluded examining differences according to FT eligibility, AFQT score, or reading grade level.

Implementation

Although personnel fleet assignment was included as a variable in this study, no differences between JPA implementation in the Atlantic and Pacific fleets were expected. However, both the feedback survey and the JPA usage survey responses indicate differences, which the acceptance data and IMP values reflected.

Comparing measures of acceptance from the feedback survey, Atlantic fleet personnel's attitudes were more positive towards JPAs. Atlantic fleet personnel (1) required less help in using JPAs, (2) found JPAs easier to handle, and (3) found JPAs easier to understand. Data from the usage survey indicate a significant difference for the infrequently occurring tasks with the Atlantic fleet preferring to use JPAs over MRCs.

The significantly higher IMP value for the Atlantic fleet seems to indicate better implementation of JPAs in the Atlantic fleet (i.e., the Atlantic fleet personnel were more willing to use JPAs for all tasks). Implementation in the Atlantic fleet occurred six months after implementation in the Pacific fleet. Since the Pacific implementation had the problem of JPAs arriving after the EPICS personnel arrived, the Atlantic implementation may have benefited from the six-month delay.

The overall IMP values indicate that, regardless of task category, less than 40 percent of the tasks performed included the use of a JPA. Transition to MRCs for frequently occurring tasks may have accounted for some reduction in JPA use.

CONCLUSIONS

1. The design of the JPAs facilitates acceptance by the users. EPICS personnel varying in FT eligibility, general aptitude, and reading ability accepted JPAs and used them as sources of information during performance of maintenance tasks.

2. JPAs provide the most support for initial performance of all tasks.

3. JPAs meet the information needs of EPICS personnel who have less aptitude for the FT rating and have lower reading ability.

RECOMMENDATIONS

1. Regardless of existing maintenance system guidelines, task frequency should be incorporated as a design criterion for JPA development in addition to the skill and aptitude level of the JPA user. Any variable that moderates the frequency of a task has to be considered. For example, a monthly scheduled task could be considered an infrequently occurring task if work center policy dictates that technicians rotate task duties in order to gain experience with a wide range of maintenance tasks.

2. The following recommendations for future JPA implementations within an integrated personnel system context are based on experience gained from EPICS:

a. JPAs should not compete with existing support documentation (e.g., MRCs) even if the target audience has no preconceptions about which form of maintenance documentation they prefer. An alternative implementation strategy might be to replace existing documentation with JPAs. All personnel, both EPICS and existing work center

personnel, would be shown how to use JPAs effectively for various types of maintenance activities. On new system developments, JPA technology can be employed at the outset to avoid competing maintenance documentation.

b. JPAs should be completely installed as support documentation prior to the arrival of the target population. JPA-targeted personnel who report to a site with existing maintenance documentation prior to JPA delivery will use the existing documentation. This will create another impediment to JPA acceptance and use when the JPAs are installed. Individuals are reluctant to change to new documentation in a different format when they are already familiar with the format of the existing documentation.

c. Work center supervisors should support the JPA implementation process. As personnel rotate frequently on Navy ships, procedures and practices have to be established to inform supervisors of their role in supporting the use of JPAs during the implementation phase. This is especially critical if maintenance documentation in a different format already exists.

d. Aptitude, skill level, experience, task frequency, and task difficulty should be integrated into JPAs of differing levels of detail. Job design should be used to establish a career structure of two or more levels of skill and experience with a subset of the overall task domain represented at each level. Ideally, an electronic medium and a digitized data base could be used to tailor JPAs with multiple levels of detail individually to the needs of each user and the type of task (i.e., level of detail would depend on the skill level of the user and/or the frequency of the maintenance task). Multilevel JPAs make the implementation strategy more flexible because, regardless of career path, all personnel could readily use it. Furthermore, the confidence of supervisors in assigning individuals to tasks would not be biased by the type of maintenance documentation used.

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